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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

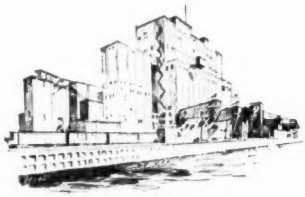
THIS ISSUE

Lubrication of Grain Handling Machinery

Flash and Fire Points

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

The Lubrication of
MATERIALS HANDLING EQUIPMENT



in the GRAIN ELEVATOR

THE machinery incident to grain handling in its removal from ship's holds, and subsequent storage, sorting and blending in the modern elevator, has received careful attention by materials handling authorities. Grain is a comparatively perishable product. As such, it is subject to rapid deterioration through premature fermentation. It is also a decided hazard due to possibility of dust explosion.

This issue of "Lubrication" explains the different types of conveying mechanisms, methods of individual drives, and adequate means for dust control and removal.

The high degree of coordination which has been attained in planning the location of such equipment, and the extent to which such coordination has reduced handling costs (which must of necessity be passed on to the ultimate consumer), should appeal to everybody.

With the return of the brewing industry and the impending repeal of the 18th Amendment, knowledge concerning the handling of grains is of added interest; for grains are the basic constituents in the manufacture of beer and the various whiskeys, where storage of the raw products must be maintained under suitable conditions of temperature and dryness to prevent fermentation.

An added factor of interest is the protection of grain handling equipment by *effective* lubrication. In this connection The Texas Company has been especially active in studying mechanical requirements and developing lubricants best suited to parts protection. Because of our enviable record in elevator operations we are able to offer to the grain handling engineer—with complete confidence—a degree of engineering service second to none. This service is offered gratis with the idea of increasing economies of operation, reducing storage hazards, and cutting maintenance and repair costs.

THE TEXAS COMPANY
Texaco Petroleum Products

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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Lubrication of Grain Handling Machinery

MODERN grain handling is a matter of conveying by endless belt or other type conveyors, using chain drives or reduction gear sets for individual operation. The economy of such installations has been thoroughly proved, although some plants still continue to use steam power and overhead shafting. Unit drive, however, is more economical of power, and far more flexible. Similar drives are also employed on blowers or exhausters for creating vacuum up to 8 inches used in suction of grain from holds of ships.

Problems incident to dust explosion are prevalent, for this reason induction type motors equipped with ball bearings are popular in modern elevators. Dust accumulation is prevented by judicious use of suction dust-gathering devices, located at certain points with respect to the carrier belts. Prevention of dust accumulation also bears directly upon lubrication in that possibility of contamination of bearing, gear and chain lubricants is reduced. In this way these products are aided in more effectively performing their intended functions. The natural consequence is reduction in maintenance and replacement costs and marked increase in power economies. The use of properly designed sealed housings for bearings, chains, and reduction gears has proved of inestimable advantage in further protecting these moving elements against unwarranted wear.

The anti-friction bearing and unit type of reduction gear drive have lent themselves admirably to grain handling service. Safety of personnel is decidedly affected by their usage, inasmuch as their location in certain parts of the elevator may often be hazardous, even for re-lubrication, not to mention repair. The use of equipment which will reduce the necessity for frequent re-lubrication and lengthen the period of useful life is therefore of material advantage.

TEMPERATURE DEVELOPMENT

Temperature control is essential in the handling of grain. This is especially necessary when grain is damp and more prone to develop chemical action, which will cause rise in temperature. Between individual particles this might be regarded as negligible. The cumulative effect of millions of such particles packed in close contact, however, must always be considered. It is for this reason that such care is taken to control bin temperatures, by use of blasts of cold air. This also prevents premature fermentation which might otherwise occur under high temperatures. Maintenance of reduced temperatures also decreases the possibility of dust explosions, which have a direct relation to temperature and the dust content of the air.

The blower has, therefore, become an important adjunct in the grain elevator. In construction it may be of either the centrifugal or rotary type. As normally designed a blower is

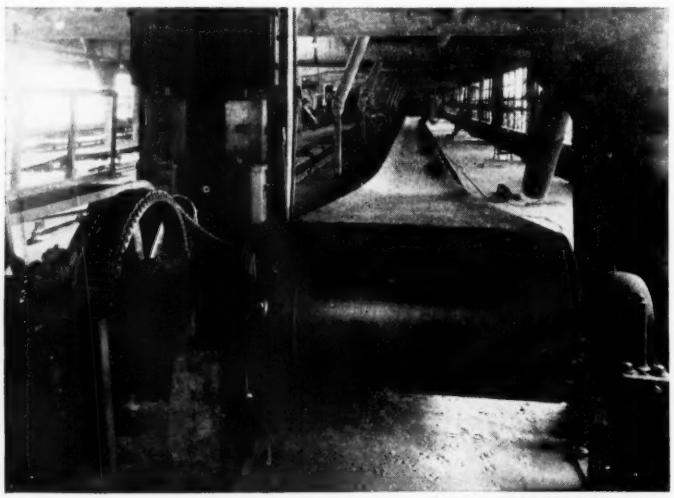
built to handle large quantities of air at low pressures, or low vacuum, according to whether blowing or suction is to be accomplished.

The centrifugal fan blower consists of a more or less scientifically designed paddle wheel, revolving in an eccentric casing. In such machines pressures of from one to two pounds or a vacuum of perhaps two inches can be maintained. Blowers of the bucket type, in turn, develop along with the centrifugal action a certain amount of added pressure or suction due to the shape of the buckets or blades. They may often impart a velocity to the air or dust somewhat in excess of the peripheral speed of the rotor.

CONVEYOR MECHANISMS

The very common usage of conveyors in grain handling operations and the usual rough service to which they are often subjected renders their maintenance and upkeep of considerable importance. Due to their rugged construction many conveyors continue to operate irrespective of the care received, the loads applied, or the manner in which wearing parts are lubricated. Some operators assume that they can neglect or even abuse conveyors almost indefinitely, and still get the results desired.

Operation of a conveyor, however, requires power, and it is amazing how power consumption will increase if operating conditions are unfavorable and frictional resistance is allowed to build up. In the modernization of grain handling equipment this has been fully realized, to the end that in the future, power consumption and lubrication problems should be markedly decreased.



Courtesy of Link-Belt Company

Fig. 1—Showing a **Link-Belt silent chain drive** operating a belt conveyor in grain elevator service.

There will always be a certain amount of friction between the bearing surfaces, rollers, chains, sprockets, and gearing, with more or less resultant wear. If this is allowed to continue, ultimately the conveyor must be cut out of service for repairs, to the detriment of production efficiency. Fortunately, friction and excessive wear can be reduced by effective lubrication, provided constructional details are correct.

Types of Conveyors— Their Construction and Purposes

Conveyors in general are built for endurance and hard service. The screw type, which is essentially a stamped or rolled steel spiral, secured by lugs to a pipe shaft, and the ribbon conveyor which consists of a ribbon flight similarly secured to the shaft, with an open space between the ribbon and shaft, are subject, probably, to the most severe service. The screw, or as it is sometimes termed, "the spiral conveyor" is designed for horizontal moving of dry materials. It is constructed to revolve in a box of steel, wood, cast-iron or concrete, according to the nature of the materials to be handled. This box carries the hanger bearings at the end.

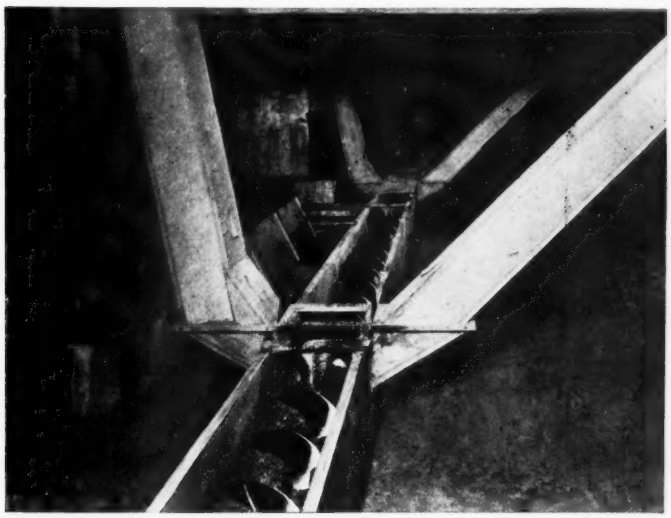
The bucket type of conveyor involves the principle of using bucket-shaped receptacles. It can be constructed for vertical as well as horizontal service. Constructional features vary but the principles are similar in all. These conveyors will handle practically any material which will not adhere to the containers. Bucket conveyors consist essentially of a pair of roller chains, or in some installations a belt, to which the buckets are attached. Either type may be vertical or inclined and have continuous or non-continuous buckets. The discharge and in-take of such a conveyor will depend upon the locality, material to be handled, and the general purposes for which handling is carried out. The bucket conveyor is the principal elevating medium in the handling of grain.

Belt conveyors are simply an endless belt of fabric designed to travel over pulleys at the conveyor ends, the loaded section being supported on trough idlers at the sides which allow the belt to form into a trough. The empty belt is supported on straight idlers. Such a conveyor will handle any material in bulk which will not adhere to it, and which can be properly fed thereto. Belt conveyors can be used for

service at from eighteen to twenty degrees incline depending on the type of material handled; they are very widely used for handling grain over the bins.

MOTOR DRIVES

Use of the electric motor is wide spread in the operation of grain elevator equipment, as the media for power transmission through chain drives or speed reduction gears. The manner of installation, however, will vary according to location of the various driven elements. Group driving from a common source of power transmission will be practicable in some elevators; in others individual drive to each exhauster, suction blower or conveyor will prevail. Regardless of the type of installation, lubrication becomes of the utmost importance, especially where gears and bearings are in close proximity and possibility of contamination of lubricants by dust may exist. The advent of the anti-friction bearing has been a welcome development to all concerned with elevator maintenance for it has enabled design and construction of bearing housings which can be more readily sealed against entry of dust. Both ball and roller bearings have been successfully applied to electric motors, in general, designed for grease lubrication.



Courtesy of The Jeffrey Manufacturing Co.

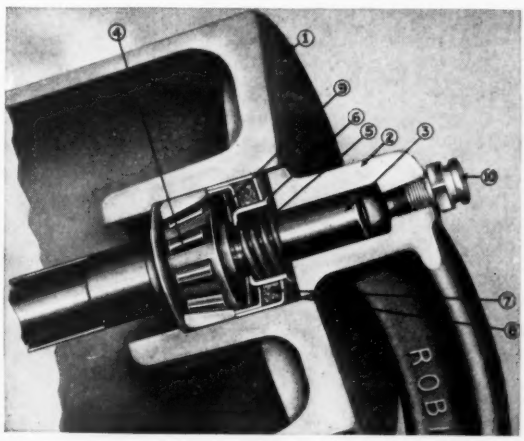
Fig. 2—Showing a Jeffrey spiral conveyor, designed for handling wheat.

Selection of Lubricants

Anti-friction bearings have an added advantage in that where they are lubricated with as nearly as possible the right amount of lubricant in conformation with structural requirements, overheating will be reduced to a marked degree. It is important to remember, however, that over-heating may occur in direct relation to the amount of lubricant used, particularly if this latter is a grease. Should such a product possess too much body, or be comparatively heavy or inert, use of an excessive quantity in any anti-friction bearing may lead to a considerable rise in temperature due almost entirely to internal friction within the grease itself. Obviously were this to continue explosion temperatures might be approached, should there be any appreciable amount of dust present in the air surrounding the bearings in question. The selection of lubricants for anti-friction bearings, must be studied with full realization of the possible hazards which may result from use of an unsuitable product.

Experience has indicated that best results will be obtained from a grease of normal consistency, capable of functioning at high temperatures, to insure against breakdown and separation, although, in general, motor, conveyor and blower bearings will seldom exceed 160 degrees Fahr., in average service.

In view of the necessity for guarding against over-lubrication, careful elevator operators observe a regular schedule for greasing all anti-friction bearings, applying but a very small amount of fresh grease at intervals of from one to three months, according to the location of the bearings, the tightness of the housings, and the time operated. Electric motor bearings



Courtesy of Robins Conveying Belt Co.

Fig. 3—Showing bearing detail of a Robins one piece cast iron pulley; (1) indicates pulley, (2) the supporting bracket, (3) hollow steel shaft, (4) Timken tapered roller bearing, (5) coil spring for maintaining proper alignment of the bearing, (6) a steel spring cup, (7) a cork washer grease seal, which remains stationary as pulley revolves, (8) steel retainer for the cork washer, (9) a fibre labyrinth washer, and (10), a high pressure grease lubricating fitting.

must be very carefully lubricated, for use of grease to any appreciable excess may lead to leakage and contact with the windings. This will be aggravated where windage, or draft occurs through the bearings and motor. Moisture might, in turn, cause arcing and sparks, which in the presence of grain dust might result in an explosion. Under extreme conditions a continuous flame has been observed adjacent to certain of such motors.

SPEED REDUCTION GEARS

The advantages of the enclosed type speed reducer have been definitely proved in grain elevator service. As the primary element in transmission of power to conveying equipment and suction blowers the speed reducer is a dominating factor in efficient operation of the entire elevator. Furthermore, inasmuch as its performance is contingent upon effective lubrication, adequate protection of gear teeth and bearings by lubricants suited to the operating conditions is absolutely essential.

In view of this fact the most serious attention should be given to choice of products which will function best under the constructional requirements and be resistant to dust contamination.

Experience has proved that for the spur or herringbone type of reduction gear a straight mineral lubricant will give best protection. It should contain no filler such as rosin or talc, etc., it should not harden, separate, gum, dry, crack or disintegrate under exposure to varied temperatures, nor become so soft as to drip or throw to excess under normal temperature rises. A lubricant of the above characteristics will possess a natural tendency to follow the gear teeth, thus increasing economy to a marked extent by virtue of the decreased frequency of application that is required. This adhering ability will of itself guarantee longer life to the gears by effectively protecting the teeth against wear. According to prevailing loads the viscosity of such a lubricant should range from that of an extra heavy motor oil to a steam cylinder stock.

Manufacturers of worm reduction gears, on the other hand, prefer a compound lubricant, of the nature of a steam cylinder oil, containing in the neighborhood of five percent of animal fat.

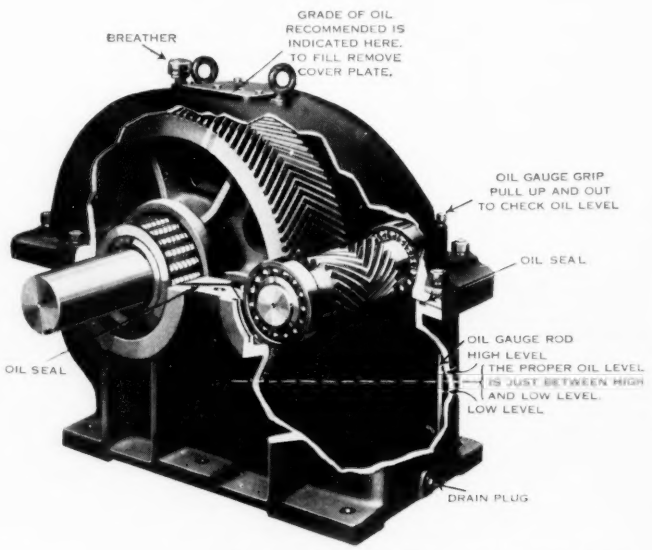
Bath or flood lubrication is provided for by builders of modern speed reduction gear sets. In such installations the bath should be just deep enough to cover the lowest teeth. This will afford ample lubrication and also keep consumption at a minimum. In a circulating system, on the other hand, a somewhat higher level will be advisable. Builders' recommendations as to the amount of lubricant to use should always be followed.

Gear Housing an Adjunct to Effective Lubrication

The necessity for keeping gear sets enclosed in comparatively oil-tight and dust-tight housings is of paramount importance in the interests of effective lubrication and prevention of wear. One must appreciate that the most essential characteristics of a good gear lubricant are that it shall have a high degree of adhesiveness and considerable body or viscosity, in order to resist the throwing-off effects of centrifugal force. These very characteristics, however, also render such a lubricant subject to rapid contamination by dust or dirt, if exposed to their influence.

Contamination of this nature is, of course, decidedly objectionable as it materially reduces the lubricating ability of a gear lubricant, converting it into more or less of an abrasive paste, according to the hardness and the extent of the foreign matter involved.

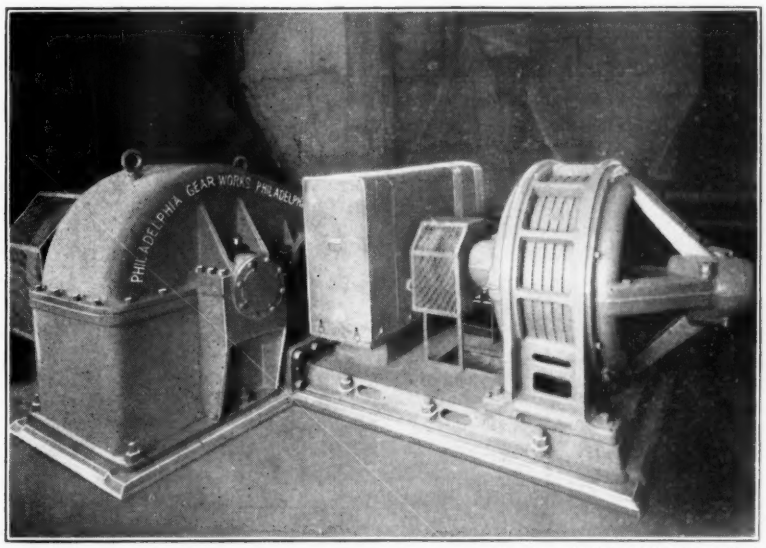
To prevent such contamination, gears, wherever possible, should be adequately protected by suitable casings. Furthermore, the fact that many gear installations will function more effectively and with less consumption of power if lubricated by a relatively fluid product, renders it all the more advisable to use oil-


GRADE OF OIL RECOMMENDED IS INDICATED HERE. TO FILL REMOVE COVER PLATE.
BREATHER
OIL GAUGE GRIP PULL UP AND OUT TO CHECK OIL LEVEL
OIL SEAL
OIL GAUGE ROD
HIGH LEVEL
THE PROPER OIL LEVEL IS JUST BETWEEN HIGH AND LOW LEVEL.
LOW LEVEL
OIL SEAL
DRAIN PLUG

Courtesy of Foote Brothers Gear and Machine Company

Fig. 4—Details of a Foote Brothers speed reduction gear, showing oiling system for the Titan type helical and herringbone speed reducers. Essential parts are clearly indicated.

tight casings. Especially is this true in the case of worm and herringbone gear installations; for this reason such designs are usually enclosed in very carefully planned housings which not only prevent entry of foreign matter, but also any leakage of lubricant.



Courtesy of Philadelphia Gear Works

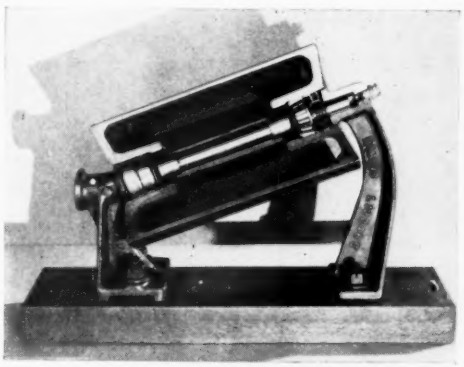
Fig. 5—Showing a double herringbone reducer, installed in grain elevator service. Note dust-proof and oil-tight housing employed.

For reasons of economy or practicability, however, many spur, bevel or other type of gear drives cannot always be so tightly enclosed. Many operators of older machinery in the face of such conditions, with a lack of appreciation of the serious potential consequences, such as wear, power losses, noise or personal hazard, will neglect to use any but the flimsiest kind of guards. Perhaps they may even allow such gears to operate absolutely open.

Gears which operate exposed either entirely or in part, will require lubricants of heavier body or viscosity than those which are tightly encased. Such a product might range in viscosity from 500 to 1000 seconds Saybolt at 210 degrees Fahr. This, of course, means that more power must be consumed in their operation for the reason that heavy lubricants impose an appreciable "drag" or braking action as the teeth pass in and out of mesh. Furthermore, the heavier the lubricant the greater will be the tendency for it to pick up and absorb dust, dirt or other abrasive solid matter.

Owing to the extent to which machinery and mechanism may vary, it can be appreciated that gear lubrication can very easily involve all manner of difficulties. Necessarily the lubricating engineer must deal with equipment as it stands, hence he must develop the best practices possible to meet and serve the conditions existing. To a certain extent recommendations are possible for alteration in bearing design, gear and bearing protection against dust, preservation and reclamation of applied lubricants, etc., but to be effective this must actually be carried out by the mechanical organization of the plant, and it requires close attention and experimentation. Observation of the above remarks as to the lubricant itself, it will be of inestimable aid to all concerned, and if selected to meet conditions, and applied as advised, gear lubricating troubles will seldom be serious.

Where gears are not contained in an oil or dust-tight housing, weekly applications are usually customary, although where the gears are entirely unguarded and dust is especially excessive, this period should be decreased somewhat. It must be remembered that a lighter grade of lubricant will last longer and yield better results under such conditions. The heavier grade that would be used under clean operation cannot be expected to maintain an efficient lubricating film under dirty conditions, due to its tendency to accumulate dust. In some cases it may even be advisable to resort to a very considerably lighter lubricant, but still one of straight mineral nature, having a viscosity of about 200 seconds Saybolt at 210 degrees Fahr., such as an automotive gear lubricant.



Courtesy of Robins Conveying Belt Company

Fig. 6—Sectional view of a Robins idler pulley.

Oil Level Important

It is essential to remember where gears are

bath lubricated that the level of the oil must be carefully watched. This will be especially true where heavier lubricants are used, and where there may be a comparatively wide range of operating temperatures, for one must remember that the development of "drag" or excessive internal friction may become a decided factor in the matter of power consumption.

As a rule where gears are bath lubricated it will be well to carry the oil level at such a height as to insure suitable dipping of the teeth of the lower element. Submergence of too much of the gear or pinion is not advisable and, as a general rule, unless comparatively fluid oils are used, it will not be necessary. The teeth will carry an adequate amount of oil up to those of the companion gear.

In the lubrication of grain elevator gears, as in the case of many other types of production machinery, it must be realized that the problem will involve more than the mere prevention of wear or noise. There will be a direct relation to continued operation.

In other words, whereas noise is nerve racking and wear will eventually necessitate replacement, back of all this is the development of detrimental operating conditions which may not only impair the quality of the product but may also increase power consumption. It is surprising how much power can be wasted as a result of neglect and lack of appreciation of the fact that gears are quite as accurately designed as any other machine parts. As a result their lubrication is of equal importance.

In view of the comparatively heavy bodied character of the lubricants usually employed for such service, these facts must be appreciated and the oil level especially must be studied in order that it may be maintained at just the right point on all installations.

There is one thought, however, which must not be overlooked. With heavier gear lubricants it will be possible to run with a somewhat lower level than where more fluid products are used. It is for this reason that reduction gear units are usually equipped with an external gauge glass to enable the operator to observe at all times just what level he is carrying.

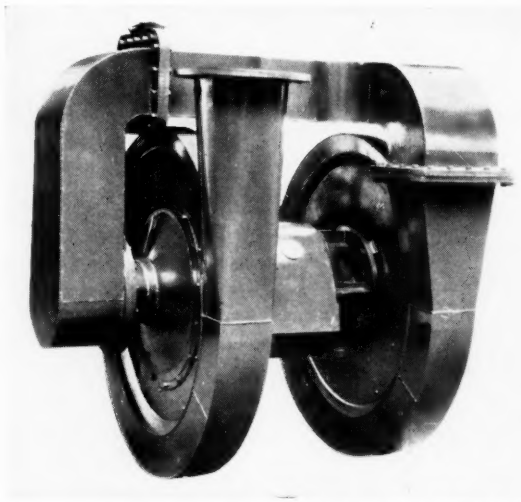
Adaptability of the Geared Motor.

The geared motor as a comparatively recent development in the field of power transmission may be expected to arouse considerable interest, due to its flexibility, ease of installation and adaptability to blower and conveyor service. By reason of its unit housing design and improved facilities for automatic lubrication it would appear to be particularly applicable to service in the presence of dust and more or less varied temperature. Bearings are no different from the bearings of the modern type of motor, being largely anti-friction, designed for grease lubrication. The reduction gear set, however, is designed for oil lubrication, the oil being contained in a bath at a sufficient level to insure proper dipping of the lower gear teeth. As a general rule it is advisable to keep the oil bath at from one-third to one-half full, so that the bottom gears will be about half submerged. For such service an oil of from 500 to 900 seconds Saybolt viscosity at 100 degrees Fahr., should be used according to the temperatures of operation and extent to which heat may be transmitted to the gear case from the motor itself.

FUNCTION OF THE BLOWER IN ELIMINATION OF DUST

Reduction of the dust content of the air in the modern grain elevator is, of course, essential in the interest of safety. There is an added advantage, however, in that personal welfare of employees is increased; cleanliness around equipment is also improved.

The suction blower or exhauster has become a most essential piece of equipment. Normally but a slight degree of vacuum is essential to remove effectively all dust from grain as it passes over conveyors. In the early stages of handling, however, as for example with suction unloaders, a vacuum of up to 8 inches may be necessary. Here, however, grain is handled bodily by suction.



Courtesy of General Electric Co

Fig. 7—Showing a G-E 2-stage centrifugal compressor driven by G-E induction motor. Every attention has been given to rendering bearings of this unit as dust-tight as possible.

Lubrication of Blowers and Exhausters

Lubrication of blowers and exhausters is essentially a matter of serving their bearings with the proper grades of oil or grease according to their design and the provisions for supplying the lubricants. In general, such equipment will be fitted with ring oilers or anti-friction bearings. As a result their lubrication will be essentially akin to that of centrifugal or rotary pump bearings, or those of the electric motor which may be of the same nature. To appreciate their lubricating requirements, a brief insight into their construction, etc., will be of interest.

Ring Oilers

The ring oiler comprises a bearing housing which is built with a reservoir and a slot of sufficient width and depth to permit one or more rings suspended from the shaft to revolve therein. As a result, with the revolution of the shaft, these rings being subjected to rotation, will carry a certain amount of oil to the top of the shaft from whence it is able to flow into the bearing oil grooves and clearance space to be ultimately distributed to the entire wearing surfaces.

As a rule, the oil after being passed through the bearing, will flow out to the end or ends of the shaft through a suitable return chamber which is part of the bearing housing, back to the oil reservoir below. Ring oilers, are not usually recommended for bearings below two inches in diameter, especially where high speeds are involved, due to occurrence of excessive slippage of the rings, and the possibility of foaming arising in the oil where reservoir capacities are limited.

Ring oiling affords a most efficient method of lubrication whereby the bearings are flooded with a considerable excess of oil over the amount that would theoretically be necessary to furnish the requisite oil film. By flooding the bearing with oil, the latter serves not only as a lubricant, but also as a cooling medium to carry away part of the frictional heat developed, thereby reducing the temperature of operation. If the oil reservoir in the base of the bearing has been properly designed and is of sufficient capacity, this overheated oil will have ample opportunity to become sufficiently cooled after each circulation by contact with the reservoir walls, particularly if the radiation of the latter is not interfered with.

Lubricating systems of this nature possess natural advantages in that the flood of oil which is constantly passing through the bearings, tends to wash out any grit, dirt, dust or metallic particles that may have gained entry, as a result, reducing wear to a minimum. On account of this washing action of the oil, however, the reservoir will gradually tend to accumulate a certain amount of sedimentary deposits. Therefore, it should be flushed out and cleaned at periodic intervals, the old oil being replaced with a fresh charge.

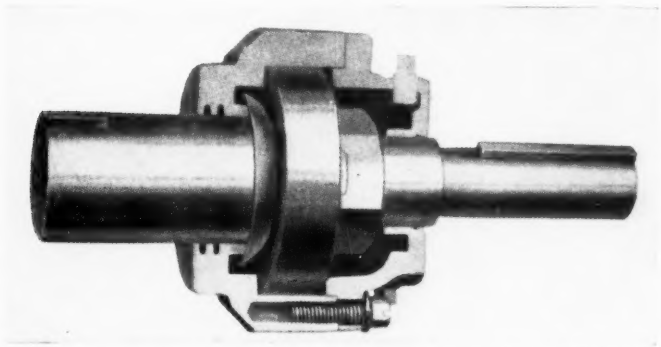
Anti-Friction Bearings

Where ball or roller bearings serve to support the journals of fans, rotors or impellers, the matter of flood lubrication is eliminated. Prevention of corrosion in such bearings, is regarded by many as perhaps the chief function of the lubricant, rather than actual reduction of friction or removal of heat.

Ball or roller bearings are advantageous in that they supplant sliding motion with rolling motion, thereby theoretically reducing the resultant friction where properly lubricated.

Wherever possible the housings should be oil-tight for thereby can we reduce the viscosity of the lubricant and in consequence the internal friction that will be developed during operation. Usually an oil of comparatively low viscosity will give the best results under such conditions.

Where leakage is possible, however, a grade of light grease should be used which will have just enough body to cause it to remain in the bearing housing. To lubricate such bearings, it is customary to charge or fill the housing and raceways with the proper grade of lubricant through a suitable fitting or hole which can be effectively closed during subsequent operation to prevent entry of dust or leakage of lubricant. In general, one charge of oil in a roller or ball bearing equipped with an oil-tight housing

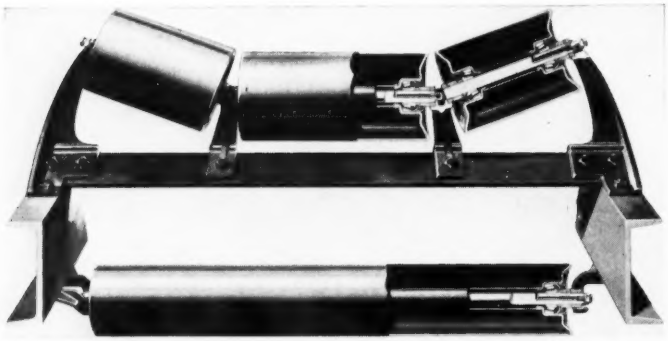


Courtesy of General Electric Co.

Fig. 8—Showing a partially sectionalized and disassembled view of cartridge-type ball bearing. This bearing is designed for grease lubrication. It is equipped with long and close shaft clearances with fibrous-grease seals which exclude dirt and retain lubricant.

should last for a period of two to three months. Where grease is required, however, it may have to be renewed more frequently, according to the extent of seal which is maintained, etc.

All fans and blowers, however, will not require or be equipped with ring oilers or anti-friction bearings. In certain cases plain bearings lubricated by grease cups, pressure gun fittings or sight feed oiling devices may be regarded as suitable by the builders, especially where operation is to be more or less intermittent. For such service a medium bodied engine oil or a plastic grade of compression cup grease will in general be found satisfactory and economical.



Courtesy of The Jeffrey Manufacturing Company

Fig. 9—Showing the Jeffrey Reliance type belt idler with bearing details and method of unit lubrication. Bearings are protected against entry of dirt by a double labyrinth grease seal.

DRIVING CHAIN LUBRICATION

Lubrication of driving chains requires careful study of operating conditions, including such factors as speed, load, clearances and extent of bending or articulation. Speed is important, since it involves the frequency of shocks due to engagement of the chain links with the gear or sprocket teeth. In other words, the greater the speed the more frequent will be the shock on each link. Whether or not shocks of this nature will be detrimental to lubrication will depend upon the load and constancy of operation. Rapid repetition of such shocks upon the bearing points of the chain may tend to force or squeeze the lubricating film out from between moving elements.

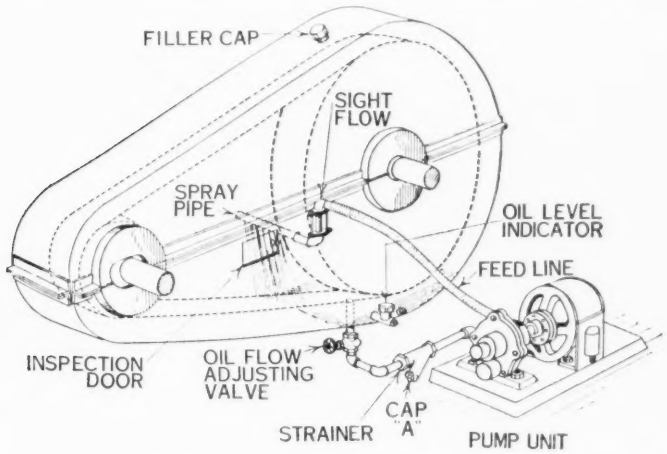
Wear is promoted by bending or articulation. In fact, bending is the chief cause of external wear, both of the chain and sprocket, notwithstanding that correct chain design tends to eliminate, as far as possible, the development of friction and external wear, confining necessary rubbing or rolling to the joints. Pins, bushings, rollers, etc., are therefore customarily built with adequate bearing surface to take up the usual strains. Still, a certain amount of external wear will be present at any event, and for this reason an adaptable chain lubricant should be capable of effectively serving both internal and external wearing points. To accomplish this it should have adequate fluidity to enable penetration throughout the entire link, whether pins and bushings, rollers or rocker joints are involved. On the other hand, to prevent external wear of teeth and chain, a sufficiently heavy lubricant should be used to withstand shocks and resist the effects of centrifugal force. This requires compromise whereby sufficient viscosity reduction is obtained to meet one purpose, yet with the retention of adhesion as much as possible.

Certain steam cylinder stocks, or reduced petroleum residuums have been proved to be excellent bases for such a type of lubricant, being blended where necessary with lighter, straight mineral products to give the desired viscosity according to the means of lubrication and type of chain. On chains of the roller type the lubricant can be brushed uniformly over the wearing surfaces while they are operating slowly. Silent chains, however, may be bath lubricated, depending upon whether they are operated exposed or in an oil-tight casing.

The speed of operation is oftentimes regarded as a guide as to whether a casing should be used. However, on drives where dust, grit or other foreign matter is present, a casing is always advisable, whatever the speed. A chain which operates in a dust-proof, oil-tight casing, which is equipped with some form of automatic lubrication, will require the least attention. Splash lubrication can be attained by means of a disc attached to one side of the main shaft. As the wheel rotates the disc dips into the oil in the base, and throws it to the top of the casing, which is built in the shape of a wedge. As a result, there is a continuous and uniform dripping of oil upon the chain. In casings of this type, the oil level is below the chain, the disc dipping in it to a depth of somewhat less than one inch. Where bath lubrication prevails, however, the oil level should be somewhat above the lowest part of the chain. Casings which are used on high speed chains, in turn, are often equipped with an oil pump, the oil being sprayed upon the chain under relatively constant pressure.

Lubrication of exposed chains is accomplished by brushing the lubricant uniformly over the driving surfaces, or by removal and immersion of the entire chain. Certain manufacturers of chains of this type treat them with the lubricant before they leave the factory.

Usually a soaking bath is used, the chains being immersed for a sufficient length of time to allow penetration to all interior parts. Such a treatment is regarded as insuring efficient lubrication over at least a month of normal operation,



Courtesy of Link-Belt Company

Fig. 10—Showing lubricating details of a Link-Belt silent chain drive. Note provisions for continuous oil flow under pressure.

if dust conditions are not excessive. Subsequent soaking of the chain in the lubricant at periodic intervals is advisable wherever possible. When it is impracticable to remove a silent chain for such treatment, the bearing or driving surfaces should be brushed with a light, uniform coating of lubricant about once a week, or more frequently if necessary. If this is done during slow operation, capillary action and bending of the chain will insure satisfactory penetration of the lubricant to all the joints.

Silent chains require the use of a relatively fluid straight mineral lubricant. When chains are encased, if they are to be bath lubricated an engine oil having a viscosity of about 500 seconds Saybolt at 100 degrees Fahr., will be suitable. Where exposed, or encased but not submerged in oil, a heavier lubricant, such as a mineral cylinder oil or light gear compound should be used.

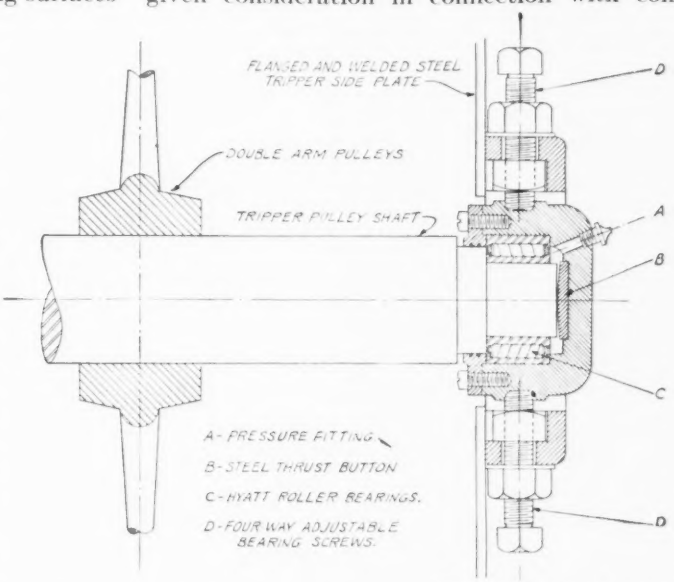
Use of greases or other semi-solid products depends upon chain design. In many cases such lubricants would serve the purpose admirably, especially on chains where there is sufficient clearance to enable proper penetration. The lubricant, however, must have a certain ability to flow, for capillary action cannot always be depended upon to bring about suitable penetration to the interior wearing parts of the chain and thorough covering of external contact parts.

THE RELATION OF MACHINE DESIGN

Effective lubrication of any type of mechanism begins in the drafting room, with the design of the parts involved and consideration of the method by which lubrication is to be accomplished. In the past there has been altogether too much tendency to regard lubrication as an after-thought, moving elements being designed with respect to their duty, and the function to be performed. Inadequate capacity of oil reservoirs, or improper location of points of lubricant application have borne witness to this many times over.

The modern grain handling machine designer, however, places the true value upon lubrication, to the extent that automatic lubrication is coming to be more and more accepted as a necessity, particularly where intricate mechanisms are involved, failure of which, due to abnormal wear, would entail considerable expense, loss of time, or interruption of elevator operation.

The extent to which lubrication has been given consideration in connection with con-



Courtesy of Link-Belt Company

Fig. 11—Showing cross-section of Hyatt roller bearing and method of lubrication of tripper pulley shaft on a low frame grain type belt conveyor tripper. Essential parts are indicated.

veyor design has been particularly noteworthy. Operating experience has dictated that all parts of the conveyor must function in as perfect unison as possible, in order to insure minimum power consumption. Bearing performance and

alignment have been proved to be of decided importance, and the utmost consideration has been given to the adoption of anti-friction bearings. By the use of these bearings it has been possible to design housings so as to eliminate much of the trouble previously experienced from entry of grain dust.

It is obvious that the designing engineer should be intimately conversant with bearing developments as they may pertain to lubrication in making original lay-outs for virtually any type of machinery. Judicious choice of means of lubrication, commensurate with the requirements of operation, will make it possible to design a machine capable of efficient economical lubrication and operation. On the other hand, where it is impossible to prevent a machine from coming in contact with abrasive, foreign matter, the designer may be justified in not giving it the same care as he would a device which can be installed apart from dust or dirt, the detrimental effects of water, or widely varying temperature conditions.

The bearings of certain types of machinery, such as the electric motor and some varieties of blowers and conveyors can be materially improved by dust-tight design, and construction in such a manner as to insure maintenance of effective lubrication. This has been materially aided by the development of the anti-friction bearing and the success achieved by the builders of such bearings in construction of dust guards and means of lubricant retention in the form of labyrinth, felt, leather or grease seals.

Influence of Design upon Lubricant Refinement

Design must be given consideration in deciding upon the degree of refinement essential in any lubricant. Wherever the design of bearings, gears, chains or other moving parts is such that they must function comparatively exposed, if it is impracticable to prevent drip or waste, a cheaper grade of lubricant can normally be recommended than where such conditions do not exist.

Such a lubricant may not possess the same lubricating ability as a more highly refined product; on the other hand, the use of the latter under such conditions would not be economical nor an assurance of any better lubrication, due to the fact that it might become unduly contaminated, with consequent reduction in its original lubricating ability. Furthermore, an initial high cost would not be justified where drip or premature waste cannot be prevented.

Waste can be prevented in many ways. They will depend to a large extent on the design of the equipment, the product being handled, the duty involved and the location. Frequently slight changes in design may solve the problem. The lubricating engineer, should study design from this point of view. He may, however, not always be able to prevail on his accounts to spend the money for alteration and installation of means of protection. It is then his duty to decide upon grades of lubricants commensurate with the existing operating conditions.

To prepare a theoretical lubrication recommendation for any specific type of machine, is more or less of an ideal, for normally it would be based upon modern design and the assumption that the builders have realized the importance of lubrication and the necessity for protecting the moving parts as much as possible. For instance, whereas a very high grade product such as a filtered mineral oil would be adaptable to such a type of design, where an older installation is involved, the engineer should use his judgment in substituting a product which, from a price point of view, will be in line with the existing conditions.

A working lubrication recommendation should include two or more grades of lubricants of varying degree of refinement; where oils are involved, however, they should be of approximately the same viscosity, commensurate with speed, operating pressure and the extent to which temperature variation may occur.

Flash and Fire Points

It is of importance to study the flash and fire points of lubricants where certain phases of exposed high temperature lubrication are involved; that is, where lubricants must be more or less directly exposed to flame, steam or electric heating mediums. Instances of this would involve the lubrication of open-hearth charging equipment in the steel industry, the lubrication of steam engines functioning on super-heated steam, or the lubrication of automatic bake oven equipment in the baking industry.

Exposure of lubricants to direct heat involves the possibility of abnormal vaporization of the more volatile constituents, to result in accumulations of non-lubricating carbon residues. Continued exposure of these latter to high heats will cause coking of such residues, with subsequent clogging of oil grooves or other vital parts of the lubricating systems, etc.

It is, therefore, essential to make a careful study of such conditions with a view to selecting lubricants which will be capable of resisting these effects of high temperature as much as possible.

VALUE AS A GUIDE TO LUBRICATING ABILITY

As a guide to the lubricating ability of any oil, flash and fire point readings are of value only as indicators of the relative initial volatility. The flash point should not be regarded as a definite temperature at which boiling takes place, or at which a petroleum product may pass even partly over to the vapor stage.

The extent to which vaporization of a motor oil, for example, may occur at temperatures below its apparent flash point will largely depend upon the proportion of low flash point or high volatility hydro-carbons which may constitute its make up and the extent to which the surface of the oil may come in contact with fresh heated air. This may be a very important factor where improperly refined oils are used, for it will lead to abnormal consumption and a false impression as to the actual cause.

Relation to Viscosity

Higher flash and fire point oils will in general be of higher viscosity if of similar composition from a hydro-carbon viewpoint. This, however, lines up with the general requirements of high temperature lubrication as brought out in the discussion of viscosity.

AUTOMOTIVE SERVICE

In automotive service the motor oil must not only be capable of functioning without an undue amount of vaporization at engine crankcase temperatures, but it must also burn cleanly at those higher temperatures to which the tops of the pistons are exposed. These temperatures also prevail, but to a lesser degree, at the upper sections of the cylinder walls. Here lubrication ceases to be a function on the occurrence of the explosion stroke. On the other hand, average cylinder wall temperatures are practically always below the flash point of any reputable oil.

Average Crankcase Temperature

The crankcase temperature can normally be regarded as the temperature of the engine bearings; a fair average the year round would be in the neighborhood of 130 degrees Fahr., although in warm weather, under hard driving conditions, the crankcase temperature may rise to as high as 250 degrees Fahr. 130 degrees Fahr., has been chosen as the standard temperature for the determination of viscosity of oils used under the lower range. For oils used under hard driving conditions or in hot summer weather 210 degrees Fahr., has been taken as the standard.

Cylinder Wall Temperatures

Cylinder wall temperatures, however, will be considerably higher, the mean average being in the neighborhood of 250 degrees Fahr., at the upper parts of the cylinders. Of course, temperatures up to 300 degrees Fahr., may be encountered, but the actual matter of lubrication at such points becomes an almost negligible factor.

In fact, no motor oil can withstand the heat of explosion in the combustion chamber, or on the uppermost part of the piston itself; nor is lubrication actually a necessity here, due to the customary practice of locating the top piston rings somewhat below the top of the pistons. So, regardless of the flash point, any motor oil which reaches the upper parts of the cylinder walls must burn. The ideal oil is that which burns as clean as possible, i.e., leaving the least amount of carbon residue.

The flash and fire points are, therefore, but interesting talking points to a certain type of motorist who is uninformed as to the actual temperature range in his engine.

Indicative of Carbon Content

On the other hand, flash and fire are frequently indicative of the probable carbon residue content of a motor oil, and here is their real significance to the motorist. In other words, with oils of approximately the same viscosity, frequently the higher the flash and fire points the higher can we expect the carbon residue content to be, especially if the oils are not highly refined.

As a result, the motorist can get some benefit out of a discussion of these characteristics, though, of course, only from a relative point of view.

OVERHEATING AND FLASH POINT IN AIR COMPRESSOR SERVICE

The subject of the heat due to compression also causes some confusion in the minds of operators as to the interpretation of the flash points of lubricating oils for air compressors.

Oils of the proper consistency which leave unusually low carbon residues are much to be preferred to oils of high flash point. Certain engineers, however, in their eagerness to secure oils of high flash point will frequently overlook this matter of subsequent carbon deposits. This is, of course, erroneous.

It is sometimes assumed that a high flash point is a desirable quality of a lubricating oil

for air compressor service. The thought is that a high flash point will prevent the loss of oil from the cylinder walls through evaporation, thereby lessening the danger of explosions. However, laboratory tests have been made with high quality, light body lubricating oils having a flash point between 310 and 325 degrees Fahr. These tests showed that negligible quantities were distilled off up to a temperature of about 615 degrees Fahr., at atmospheric pressure.

It appears that the rapidity of evaporation of an oil, as well as its tendency to carry oil vapors from the cylinder wall film over to the discharge pipes and intercoolers is not governed by the flash point alone. Moreover, even with an oil of too high a viscosity for compressor lubrication, a temperature of about 600 degrees Fahr., would not generate sufficient vapors to form an explosive mixture. Since the discharge temperatures in air compressors range in the neighborhood of 325 to 375 degrees Fahr., and since the cylinder walls are always jacketed it is evident that the oil film on the wall has a temperature lower than the discharge air.

ACTUAL MEANING OF TERMS "FLASH" AND "FIRE"

When the temperature of a petroleum product is gradually raised, a point will be reached where enough surface vapor is developed to ignite for a moment upon the application of a flame. The temperature of the oil at the moment of flash is regarded as the flash point of the product under test.

This test for flash point is arbitrary in that it depends upon the type of apparatus used, i.e., whether this latter employs an open or closed cup. In the United States the open cup prevails in the testing of lubricating oils, the closed cup device being more largely confined to foreign usage, or to oils of intermediate flash point.

METHOD OF TEST

The open cup flash and fire test as determined with the Cleveland open cup has been designated by the American Society for Testing Materials and other organizations as the standard method of test for petroleum lubricating oils.*

"Procedure

"(a) The thermometer shall be suspended or held in a vertical position by any suitable device. The bottom of the bulb shall be ¼ in. (0.635 cm.)** from the bottom of the cup, and above a point half way between the center and back of the cup.

"(b) The cup shall be filled with the oil to be tested in such a manner that the top of the meniscus is exactly at the filling line at room temperature. The surface of the oil shall be free from bubbles. There shall be no oil above the filling line or on the outside of the apparatus.

"(c) The test flame shall be approximately 5/32 in. (0.397 cm.) in diameter.

"(d) The test flame shall be applied as the temperature read on the thermometer reaches each successive 5 degree Fahr., mark. The flame shall pass in a straight line (or on the circumference of a circle having a radius of at least 6 in.) across the center of the cup and at right angles to the diameter passing through the thermometer. The test flame shall, while passing across the surface of the oil, be in the plane of the upper edge of the cup. The time for the passage of the test flame across the cup shall be approximately one second.

"(e) The oil shall be heated at a rate not exceeding 30 degrees Fahr., per minute temperature rise, till a point is reached approximately 100 degrees Fahr., below the probable flash point of the oil. Thereafter the rate of heating shall be decreased and for at least the last 50 degrees Fahr., before the flash point is reached, the rate shall be not less than 9 nor more than 11 degrees Fahr., per minute.

"The flash point shall be taken as the temperature read on the thermometer when a flash appears at any point on the surface of the oil. The true flash must not be confused with a bluish halo that sometimes surrounds the test flame.

"After determining the flash point, the heating shall be continued at the specified rate of 9 to 11 degrees Fahr., per minute, and application of the test flame shall be made at the specified intervals until the oil ignites and continues to burn for a period of at least 5 seconds. The method of application of the flame shall be the same as for flash point. The temperature read at the time of the flame application which causes burning for a period of 5 seconds or more shall be recorded as the fire point.

"The flash point and fire point tests shall be made in a room or compartment free from air drafts. The operator shall avoid breathing over the surface of the oil. It is desirable that the room or compartment be darkened sufficiently so that the flash may be readily discernible."

* American Society for Testing Materials Designation D 92-24, page 112, Report of Committee D-2 on Petroleum Products and Lubricants, and Methods of Test Relating to Petroleum Products, 1932; also, American Petroleum Institute, Standard A.P.I. No. 511-29, and American Standards Association, A.S.A. No. Z, 11.6-1928.

** The immersion line engraved on the thermometer stem will be 1/16 in. (0.159 cm.) below the level of the rim of the cup.

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